2.—An oval australite core from Lake Ballard, Western Australia

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Abstract

An australite core from Lake Ballard weighs 200.29 g and is the fourth australite of weight exceeding 200 g known from Western Australia. From the radii of curvature of the posterior surface of the core the volume of the primary spheroid has been calculated as approximately 268 cubic centimetres. About 69% of the volume of the primary spheroid and 44% of its thickness have been lost by the action of processes operating during atmospheric flight and by subsequent terrestrial erosion.

Introduction

A large australite core was found by Mr. L. P. Berryman in May, 1968 on the dry floor of Lake Ballard and near its western end. The site of discovery is 107 miles N.N.W. of Kalgoorlie and has approximate co-ordinates 120° 36′ E., 29° 21′ S. Some small chips (possibly aggregating 0.1g) were broken from the core by rough handling before the nature of the find was understood.

The weight of the cleaned core is 200.29 grams. It is the fifth heaviest australite known to science, three heavier ones being known from Western Australia, and another from South Australia.

The locality of the find is 165 miles N.E. of Warralakin in what may be regarded as an extension of a known area of concentration of large australites (McCall 1965; Baker 1966, 1967). This concentration tends to assume the form of a belt athwart the australite strewnfield. The other three Western Australian australites of weights exceeding 200 g were found within this belt near Warralakin, Newdegate and Lake Yealering; their sites and those of other large Western Australian australites have been figured by McCall (1965) and Baker (1967).

Morphology and surface features

The core is slightly oval in plan view (Fig. 1A), the anterior surface (which faced earthwards down the flight path) merging into a flaked equatorial zone which terminates rearward at an illdefined rim (Fig. 1B); the rim separates the flaked equatorial zone from the posterior surface (an eroded remnant of the surface of the parental spheroid).

Two curved and roughly lozenge shaped flakes (38 x 17 and 31 x 17 mm), which may have attained 3 mm thickness at their centre points, and two smaller flakes have been lost from around the rim; the scars incline toward the posterior surface at an angle flatly oblique to the equatorial zone. Another scar overlaps the flaked equatorial zone from the anterior surface and represents the loss of a thin but extensive flake (35 x 18 mm). The surfaces of the scars are completely frosted and the outlines smoothed; etched grooves are present, some being continuous with those of the posterior surface, but the depth of etching is not as great as on the two main surfaces.

The cause of this flaking (not to be confused with the loss of small flakes from the equatorial zone during flight) is unknown, but it is clearly not of recent date. Loss as a result of impact appears improbable; in most cases, blows would need to have been struck from the direction of the posterior surface to be effective. The two large rim flakes almost meet at a blunt point, and the possibility of "working" by aborigines was considered, but it is difficult to envisage a

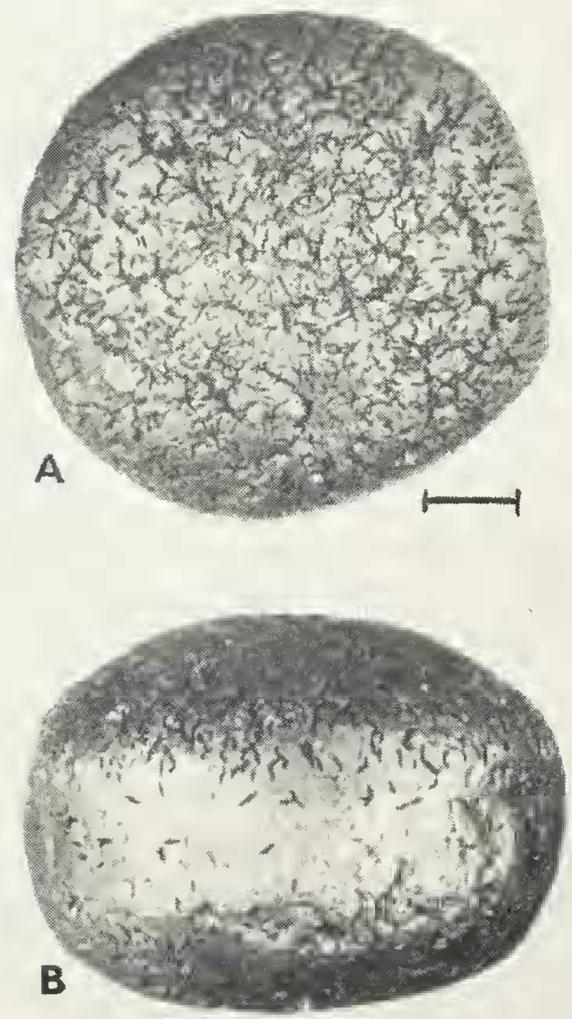

Figure 1.—The Lake Ballard oval australite core. A.—Posterior surface showing severe terrestrial etching effects. Angularity at lower right resulting from natural loss of two large flakes from the rim. B.—Side view, anterior surface at bottom of photograph. Left profile affected by natural flake loss. Scale bar one centimetre.

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use for an artefact with such a blunt and asymmetrically disposed point, except perhaps as a lethal stone (death pointer) or a punishment stone (Baker 1957); the "point" is undamaged by percussion. Natural spallation after landing seems most likely, followed by natural solution-etching and some mechanical abrasion.

Terrestrial abrasion and solution etching have been understandably severe because the site of find is a lake basin subject to the periodic drying out of saline and gypseous water; temperature ranges in the region are large: blown sand is an active abrading agent on the floors of such lakes. The lustre of the core is uniformly dull and the finer sculptural details usual on well preserved australites are absent.

The posterior surface is dominated by etched grooves of V-shaped cross section, often attaining one mm deep, occasionally solitary or in radiating "birdtracks", but united over most of the surface into a continuous crazed pattern which leaves small rounded or reduced plateau remnants of the original surface; etched lunate or circular "bruise marks" and small pits are recognisable only near the rim.

Smoothly scalloped areas on the flaked equatorial zone represent loss of flakes during the end stages of atmospheric flight and subsequently after landing as a consequence of spallation of the aerothermal stress zone—c.f. Baker (1963b). Grooves on this zone are shallow, about 1 mm wide, U-shaped in section, and have smoothed outlines; most are parallel to the line of flight and some extend over the full width (12-15 mm) of the flaked equatorial zone. There are numerous shallow pits, rarely attaining 1 mm diameter.

The anterior surface is less severely etched than the posterior surface and has a "birdtrack" pattern of grooves, several etched "bruise marks", and shallow pits distributed sparsely over the whole surface.

The etched pattern is distinctly radial near the edges of both the anterior and posterior surfaces. It is therefore likely to have been initiated by a process which affected the mass as a whole (such as the etching out of more susceptible schlieren related to rotation of the primary mass) rather than to radial streaming during atmospheric flight, which would have affected the anterior surface preferentially.

Dimensions of the core and the primary mass

The dimensions of the core are 60 x 57 x 44 mm thick. The thickness is greater than that of any of the large cores listed by Baker (1966), though considerably exceeded by that of the Newdegate core (Western Australian Museum No. 12318), which has a thickness of more than 52 millimetres.

Radii of curvature along the shorter and longer oval axes of the anterior surface (R_F) and posterior surface (R_B) were measured from enlarged silhouettes (c.f. Baker 1956 p. 57), but because of severe etching and erosion effects, the radii must be regarded as approximate. The values are:—

R_F = 39mm and 47mm

R_B = 39mm and 42mm

Assuming that the primary australite form was a biaxial ellipsoid with the same radii as the posterior face of the core, it would have had dimensions 7.8 x 7.8 x 8.4 cm and a volume of 268 cm^3 (nearly).

Losses from the primary form

The volume of the remnant core is 82.27 cm^3 and its thickness is 44 millimetres. About 69% of the volume and about 44% of the thickness of the primary form have therefore been lost by processes operating during atmospheric flight, by flaking of uncertain cause, and by terrestrial abrasion and solution etching.

The flaking is estimated to account for less than 1% loss. Terrestrial losses are difficult to assess, but they were certainly significant. It may be suspected from the intensity of etching towards the centre of the posterior surface that the arcs of curvature of that surface have been somewhat flattened and the radii of curvature increased; the volume of the primary spheroid might therefore have been over-estimated and thus also the percentage losses. The evident asymmetry of the anterior surface may be attributed to terrestrial processes because the presence of such asymmetry during atmospheric flight would have led to instability, for which no evidence was noted.

The percentage losses in forming the Lake Ballard core are greater than those for the Warralakin core (Baker 1962b), and it is also clearly evident from inspection that they were much greater than for the Newdegate core, the unusually deep form of which has been aptly described by McCall (1965) as "globular". Losses were, however, less than those for the Graball core and less than the mean losses for the well preserved Port Campbell cores (Baker 1963a, 1962a).

Such variable volume losses are attributable to a combination of different amounts of abrasion and/or solution etching according to different degrees of terrestial erosion, coupled with differential aerodynamic ablation and fusion stripping of primary forms of somewhat different size and slightly varying angles of transit through the atmosphere.

Refractive Index and Specific Gravity

The glass constituting the core from Lake Ballard is translucent, smoky, and yellowish on thin edges. A minute flake from the chipped posterior surface is isotropic and has $^{n}N_{\lambda}$=1.512

A single inclusion noted in the flake is oval in section and has dimensions 75 x 33 microns. It is isotropic and of distinctly lower refractive index than the enclosing glass; it is probably lechatelierite.

The specific gravity of the core (T_{H_2O} 20°C) is 2.435.

The specific refractivity is 0.2103.

TABLE 1

Comparison of Graball and Lake Ballard australite cores

	Graball core	Lake Ballard core
Primary body, radius, cm	8	7·8 x 7·8 x 8·4
Primary body, volume, cm^3	268	268
Specific gravity, core	2·434	2·435
Volume loss (all causes), %	74	69
Thickness loss (all causes), %	43	44

Conclusions

The Lake Ballard australite shows the usual features of large cores and a complex pattern of natural solution etch-grooves. As indicated in Table 1, there are points of close resemblance to the large round Graball core (Baker 1963a), from which it differs principally in having been derived from an imperfectly spherical parent mass and in its somewhat smaller losses during atmospheric transit. Because terrestrial losses have been especially severe when compared with the "reasonably well preserved" Graball core, the Lake Ballard loss figures should be reduced somewhat before making a comparison of atmospheric losses.

The chance discovery of the Lake Ballard core by a member of a mineral exploration party confirms the existence of a Western Australian concentration of unusually large australites and suggests that this concentration may take the form of a more or less meridional belt across the strewnfield. However, so much of the area has been so imperfectly collected, that it would be unwise to draw further conclusions.

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